Occupation and risk of stomach cancer in Poland

S Krstev, M Dosemeci, J Lissowska, W-H Chow, W Zatonski and M H Ward

Occup. Environ. Med. 2005;62;318-324
doi:10.1136/oem.2004.015883

ORIGINAL ARTICLE

Occupation and risk of stomach cancer in Poland

S Krstev, M Dosemeci, J Lissowska, W-H Chow, W Zatonski, M H Ward

Occup Environ Med 2005;**62**:318–324. doi: 10.1136/oem.2004.015883

See end of article for authors' affiliations

Correspondence to: Dr M H Ward, Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, 6120 Executive Blvd, EPS 8104, Bethesda, MD 20892, USA; wardm@mail.nih.gov

Accepted 6 January 2005

Background: In spite of the dramatic decline in the incidence of stomach cancer in the twentieth century, Poland has one of the highest rates in the world.
Aims: To evaluate the risk of stomach cancer by grouped occupations and industries, as well as by some specific occupational exposures.
Methods: Cases (n = 443) were newly diagnosed with stomach adenocarcinomas between 1994 and 1996. Controls (n = 479) were randomly selected from the general population in Warsaw.
Results: Only a few occupations and industries were associated with significantly increased risks of stomach cancer. The most suggestive finding was for work in the leather goods industry. Risk was also significantly increased among men working in fabricated metal production and among women ever employed as managers and governmental officials. Men ever employed as teaching professionals and women employed as technical and science professionals had significantly decreased risks of stomach cancer. Among men, a significant positive trend in risk with duration of employment was observed for work in the leather industry and special trade construction. No significantly increased risks were observed for specific exposures assessed by a job-exposure matrix or by self-reports. However among men there were non-significantly increased risks with 10 or more years exposure to asbestos, metal dust, and nitrosamines assessed by a job-exposure matrix.
Conclusions: Employment in the leather goods industry, special trade construction, and metal fabrication was associated with an increased risk of stomach cancer among men. However, there were only weak associations with specific exposures. Occupational exposures do not contribute substantially to the high rates of stomach cancer in Poland.

Although the incidence of stomach cancer declined dramatically in the twentieth century, worldwide stomach cancer is still one of the most common causes of cancer mortality.[1] It is the second most frequent cancer, accounting for 9.9% of cancer cases and 12% of cancer deaths annually.[2 3] The countries of Eastern Europe including Poland have some of the highest stomach cancer rates in the world.[4]

Occupational risk factors for stomach cancer are not well established. The studies to date do not suggest a strong role for any specific occupational carcinogen.[1 5–8] However, jobs with exposures to mineral and metal dusts, coal dust, wood dust, silica, and asbestos have frequently been associated with an increased risk of stomach cancer. Various types of dusts could cause irritation to the gastric mucosa, which in turn could cause inflammation and increased cell proliferation.[6–8] Alternatively, dusts may act as a carrier of carcinogens to the gastric mucosa. N-nitroso compounds are potent animal carcinogens and have been hypothesised to play a role in stomach cancer risk.[9–11] Exposures to N-nitroso compounds occur across a number of jobs and industries that have been associated with an increased stomach cancer risk, including the rubber industry, foundries, metal machining and grinding, and pesticide manufacturing.

In this report, we evaluated occupational histories and self-reported information on specific exposures in relation to stomach cancer risk in a population based case-control study in Poland. We also used a job exposure matrix to assess exposure to specific dusts, asbestos, nitrosamines, and pesticides.

METHODS

We conducted a population based case-control study of stomach cancer among Warsaw residents. The study was reviewed and approved by Institutional Review Boards at the US National Cancer Institute and the Cancer Centre and Institute of Oncology of Health in Warsaw. The study design, subject selection, and pathologic confirmation of the diagnosis have been described elsewhere.[12–14] Briefly, all newly diagnosed cases of stomach adenocarcinomas in patients aged 21–79 between 1 March 1994 and 30 April 1996 were identified by collaborating physicians in all 72 clinics and endoscopic departments within 22 hospitals, and eight private endoscopic units serving Warsaw city. To ensure completeness of case ascertainment, records of the cancer registry were also checked regularly. For each case, tissue slides or specimens were obtained and reviewed by two pathologists. Cases were classified using the Lauren classification into intestinal type (n = 310, 66.8%), diffuse (n = 66, 14.2%), and indeterminate (n = 88, 19.0%).

Using a computerised registry of all legal residents in Poland, controls were randomly selected from the general population of Warsaw, and frequency matched to the cases by gender and five-year age groups.

Interviews

In-person structured interviews were conducted for controls, cases, and the next-of-kin of deceased cases. Of the 515 eligible cases identified, 34 (6.6%) refused and 17 (3.3%) were untraceable or unavailable for other reasons. A total of 464 (90%) stomach cancer patients (302 men and 162 women) participated in the study. Interviews were conducted with 324 cases (69.8% of those interviewed) in person and with the next-of-kin of 140 (30.2%) cases. A total of 480 of 549 eligible controls were successfully interviewed, yielding a response rate of 87.4%.

Information was obtained about demographic characteristics, occupation and residence histories, childhood living conditions, history of selected medical conditions and

Abbreviations: OR, odds ratio; CI, confidence interval; n, number

Main messages

- In spite of the dramatic decline in the incidence of stomach cancer in the twentieth century, Poland has one of the highest rates in the world.
- Occupational exposures have not been extensively evaluated as risk factors for stomach cancer.
- In this population based case-control study of stomach cancer among men and women in Warsaw, Poland, there was a positive trend in risk with duration of employment in the leather industry and special trade construction among men.
- Risk was also significantly increased among men working in fabricated metal production and among women ever employed as managers and governmental officials.
- Asbestos, nitrosamines, and specific types of dusts have been hypothesised to be risk factors.
- Modest increased risks were found with 10 or more years of exposure to asbestos, metal dust, and nitrosamines.

Policy implications

- Findings for leather goods production, asbestos, and metal dust exposure support findings from previous studies.
- Results suggest that the high rates of stomach cancer in Poland are not substantially explained by occupational exposures.

medication use, family history of cancer, diet, and tobacco and alcohol consumption. An ever-smoker was defined as a smoker of at least one cigarette per day for six months or longer. Those who stopped smoking within the prior two years were considered current smokers.

We obtained a lifetime history of every job that was held for one year or longer, including full and part time jobs, paid and non-paid jobs. For each job, we asked about the main activities and duties, the branch of industry, and the year in which the job started and ended. Additional information was collected on exposures to coal dust, metal dust and fumes, lead dust and fumes, welding fumes, cutting fluids and oils, gasoline and kerosene, fibreglass or other synthetic fibres, asbestos, sand dust (silica), pitch, asphalt, creosote, and tar, organic dusts, grain dust, pesticides and fertilisers, and diesel exhaust. For each exposure, we also obtained the first year and the total years of exposure.

Data analysis

Occupations were coded using ISCO-1988 (International Labour Organisation International Standard Classification of Occupations, ISCO-88) and industries were coded using the 1987 Standard Industrial Classification (SIC) (Office of Management and Budget, 1987). We grouped three digit ISCO occupations and SIC industries according to similar exposures and analysed men and women separately. Analyses of individual four and three digit occupations and industries were limited by small numbers; therefore, three digit occupations were grouped into 18 categories and industries into 32 categories. We evaluated employment for at least one year in these occupational and industry categories (ever/never analyses) compared with no employment in that occupation or industry group. Cumulative duration of employment for each occupation and industry category was calculated by summing the duration of all jobs in the category up through the reference date (date of diagnosis for cases, date of interview for controls). We weighted part time jobs by 0.5. Duration of employment in the occupation or industry was analysed in categories of 1–9 years and 10 or more years. We also calculated risk for ever having self-reported exposure to each type of agent, as well as by duration of exposure (1–9, 10+ years). Trend tests were performed by assigning scores to duration categories and treating the scored variables as continuous variables in the logistic analyses.

In addition, we lagged the occupation and industry and self-reported exposure variables by not counting the last 10 years of exposure before the reference date. The results of the lagged analyses did not differ from our original results and

Table 1 Odds ratios (ORs) for stomach cancer by occupational groups among men and women

	Men		Women	
Occupation	Cases/controls	OR* (95% CI)	Cases/controls	OR* (95% CI)
Armed forces	48/58	1.1 (0.7 to 1.7)	1/2	1.6 (0.2 to 12.1)
Agricultural and fishery workers	42/57	0.9 (0.5 to 1.4)	12/23	0.7 (0.3 to 1.5)
Handcraft and trade workers in various material	50/60	0.8 (0.5 to 1.3)	27/29	1.1 (0.6 to 2.0)
Health professionals	1/8	0.2 (0.02 to 1.3)	4/9	0.6 (0.1 to 2.1)
Homemaker	2/0	INF†	62/69	1.3 (0.8 to 2.3)
Inspectors and vehicle controllers	10/9	1.4 (0.5 to 3.6)	0/1	IDF‡
Legal and social science professionals	29/35	1.0 (0.6 to 1.8)	16/15	1.1 (0.5 to 2.5)
Machine and plant operators	10/12	0.9 (0.4 to 2.1)	6/10	0.7 (0.2 to 2.1)
Managers and governmental officials	41/57	1.1 (0.7 to 1.8)	18/11	2.6 (1.1 to 6.1)
Manufacturing labourers	10/13	1.0 (0.4 to 2.5)	15/12	1.6 (0.7 to 3.8)
Metal workers	71/83	1.0 (0.7 to 1.5)	5/10	0.4 (0.1 to 1.4)
Mining and construction workers	41/55	0.7 (0.4 to 1.2)	3/4	0.9 (0.2 to 5.0)
Office workers	49/60	1.2 (0.8 to 1.9)	64/59	1.6 (0.9 to 2.7)
Personal service workers	23/39	0.7 (0.4 to 1.2)	26/35	0.9 (0.5 to 1.8)
Salespersons	11/6	2.6 (0.9 to 7.5)	22/25	1.0 (0.5 to 1.9)
Teaching professionals	12/38	0.4 (0.2 to 0.8)	10/15	0.8 (0.3 to 2.0)
Technical and science professionals	70/89	1.0 (0.7 to 1.5)	9/24	0.4 (0.2 to 0.9)
Transport and freight handlers	48/44	1.3 (0.8 to 2.2)	7/9	1.1 (0.4 to 3.2)

*ORs for ever employment in specific occupational groups adjusted for age, education, smoking, and number of jobs.
†Infinity.
‡Indefinite.

Table 2 Odds ratios (ORs) for stomach cancer by industry groups among men and women

	Men		Women	
Industry	**Cases/controls**	**OR* (95% CI)**	**Cases/controls**	**OR* (95% CI)**
Agriculture, crops	33/50	0.7 (0.4 to 1.2)	10/22	0.6 (0.2 to 1.3)
Agriculture, livestock/fishing	5/5	1.5 (0.4 to 5.5)	0/1	IDF†
Agriculture and forestry services	9/11	1.2 (0.5 to 3.0)	3/4	1.6 (0.3 to 7.5)
Amusement and recreational services	7/11	0.8 (0.3 to 2.0)	9/6	1.8 (0.6 to 5.8)
Automotive and other repair shops	22/24	1.2 (0.6 to 2.2)	0/2	IDF†
Chemical products	13/22	0.7 (0.4 to 1.5)	10/8	1.4 (0.5 to 3.9)
Communication services	1/2	0.8 (0.1 to 9.9)	5/4	0.7 (0.1 to 3.3)
Educational services	13/41	0.4 (0.2 to 0.8)	19/25	0.9 (0.4 to 1.9)
Electric machinery and equipment	20/31	0.7 (0.4 to 1.4)	4/14	0.3 (0.1 to 1.0)
Financial institutions	9/18	0.7 (0.3 to 1.7)	9/11	1.4 (0.5 to 3.7)
Food and tobacco products	24/24	1.4 (0.8 to 2.6)	11/13	0.9 (0.4 to 2.4)
General construction	52/74	0.7 (0.5 to 1.1)	11/10	1.4 (0.5 to 3.6)
Glass, clay, cement, stone products	7/8	1.2 (0.4 to 3.4)	5/4	2.3 (0.6 to 9.5)
Health services	7/8	1.4 (0.5 to 4.2)	12/16	0.9 (0.4 to 2.0)
Instruments, jewellery, and toys	15/20	1.2 (0.6 to 2.5)	3/7	0.5 (0.1 to 2.1)
Leather goods	8/2	5.1 (1.0 to 25.0)	4/3	3.1 (0.7 to 14.9)
Machinery manufacturing	35/48	0.9 (0.5 to 1.5)	1/8	0.1 (0.01 to 0.9)
Metal products, fabricated	23/17	2.1 (1.1 to 4.2)	3/7	0.3 (0.1 to 1.4)
Metal products, primary	7/12	0.9 (0.3 to 2.3)	0/1	IDF†
Mining	7/8	1.1 (0.4 to 3.1)	1/0	INF‡
National security	68/84	1.1 (0.7 to 1.7)	8/9	1.2 (0.4 to 3.4)
Other governmental agencies	35/61	0.8 (0.5 to 1.2)	16/20	1.1 (0.5 to 2.4)
Personal, social, and business services	42/56	1.0 (0.6 to 1.5)	26/30	1.2 (0.6 to 2.2)
Publishing	18/14	1.7 (0.8 to 3.5)	8/7	1.3 (0.4 to 4.0)
Railroad, highway, and water transportation	37/57	0.7 (0.4 to 1.2)	4/6	0.9 (0.2 to 3.3)
Retail stores	38/42	1.2 (0.7 to 2.0)	46/45	1.4 (0.8 to 2.4)
Sanitary, electricity, water supply services	6/7	1.1 (0.4 to 3.5)	2/2	1.7 (0.2 to 12.6)
Special trade construction	22/13	1.9 (0.9 to 4.0)	0/3	IDF†
Textile outwear, fabricated	8/11	0.7 (0.3 to 1.9)	15/15	1.2 (0.6 to 2.8)
Transportation vehicle and equipment	28/37	0.9 (0.5 to 1.6)	5/8	0.7 (0.2 to 2.3)
Wood and related products	10/20	0.6 (0.3 to 1.2)	2/2	1.8 (0.2 to 13.8)

*ORs for ever employment in specific industrial groups adjusted for age, education, smoking, and number of jobs.
†Indefinite.
‡Infinity.

are not presented here. We conducted additional analyses that excluded cases with next-of-kin respondents, and report results after exclusion of next-of-kin when they differed from results for all respondents by approximately 20% or more.

To better assess exposure to specific occupational agents that have been associated with stomach cancer, an experienced industrial hygienist (MD) created a job-exposure matrix (JEM). For each occupation and industry combination, exposure to general dust, organic, inorganic, and metal dust, asbestos, pesticides, and nitrosamines was assigned (exposed versus non-exposed).

A total of 18 men and four women were excluded from the occupation and industry analyses because of missing information on occupation, industry, education, or smoking. Therefore, the total number of subjects in our analyses was 443 cases (285 men, 158 women) and 479 controls (313 men, 166 women). For the analysis of self-reported exposure, we only excluded subjects with missing data on the specific self-reported exposure, smoking, and education.

Odds ratios (ORs) and 95% confidence intervals (CI) for stomach cancer were estimated by unconditional logistic regression analysis. All analyses were adjusted for age (<50, 50–59, 60–69, and ⩾70 years), education (elementary school, high school, college, or beyond), smoking (non-smoker, former smoker, current smoker), and the number of lifetime jobs held. Additional adjustment for pack-years of smoking, family history of stomach cancer, respondent type, quartiles of weekly intakes of fruit and fruit juice, bread, cereals, rice and pasta, sausage, and red meat, did not change the risk estimates by 20% or more and are not presented. We had sufficient numbers of cases to evaluate exposures assessed by the JEM separately for the Lauren intestinal and diffuse histological types of stomach cancer and separately for smokers (past and current) and non-smokers.

RESULTS

The demographic and other characteristics of cases and controls have been described previously.[12–14] The mean age at reference date was 63.8 years for cases and 63.7 years for controls. Controls tended to have a higher educational level than cases (college degree: controls 26.5%, cases 21.3%). A higher proportion of cases had ever smoked (cases 65.1%, controls 55.2%).

The average number of jobs held was 2.7 for cases and 3.4 for controls. The average length of employment was 33.4 years for cases and 35.2 years for controls.

The ORs associated with ever having been employed in specific occupational groups are presented in table 1 separately for men and women. We observed a significantly increased risk of stomach cancer for managers and governmental officials among women (OR = 2.6, 95% CI 1.1 to 6.1), but not among men (OR = 1.1, 95% CI 0.7 to 1.8). We observed increased risks of borderline significance for women who worked as office workers and for men who worked as salespersons. Risk was significantly reduced among men employed as teaching professionals and among women who were technical and science professionals.

Table 2 shows the odds ratios associated with ever being employed in specific industries. Among men, risk was significantly increased with employment in fabricated metal products (OR = 2.1, 95% CI 1.1 to 4.2) and there was borderline increased risk for employment in special trade construction (OR = 1.9, 95% CI 0.9 to 4.0) and leather goods (OR = 5.1, 95% CI 1.0 to 25.0). The number of women employed in these industries was small. Risk was increased for women in the leather goods industry (OR = 3.1, 95% CI 0.7 to 14.9) but not in special trade construction or fabricated metal products. Among women, there was a significant inverse association for work in machinery manufacturing

Table 3 Odds ratios (ORs) for stomach cancer by duration of employment in selected occupation and industry groups among men

	Duration (years)			
	1–9		⩾10	
	Cases/controls	OR* (95% CI)	Cases/controls	OR* (95% CI)
Occupational groups				
Agricultural and fishery workers	24/43	0.7 (0.4 to 1.3)	16/14	1.1 (0.5 to 2.3)
Inspectors and vehicle controllers	3/4	1.1 (0.2 to 5.3)	7/5	1.6 (0.5 to 5.2)
Machine and plant operators	6/3	2.5 (0.6 to 10.5)	4/9	0.4 (0.1 to 1.4)
Metal workers	27/40	0.9 (0.5 to 1.7)	44/43	1.1 (0.7 to 1.8)
Mining and construction workers	16/36	0.5 (0.3 to 1.0)	25/19	1.0 (0.5 to 2.0)
Salespersons	8/6	2.0 (0.7 to 6.3)	3/0	INF†
Teaching professionals	9/15	0.9 (0.3 to 2.1)	3/23	0.13 (0.04 to 0.46)
Transport and freight handlers	20/19	1.6 (0.8 to 3.3)	28/25	1.2 (0.6 to 2.2)
Industrial groups				
Agriculture, crops	19/35	0.7 (0.4 to 1.2)	13/15	0.8 (0.3 to 1.7)
Agriculture, livestock, and fishing	3/3	1.8 (0.3 to 9.7)	1/2	0.6 (0.1 to 6.4)
Agriculture and forestry services	5/10	0.7 (0.2 to 2.2)	4/1	5.6 (0.6 to 51.9)
Financial institutions	3/13	0.3 (0.1 to 1.2)	6/5	1.8 (0.5 to 6.3)
Food and tobacco products	15/15	1.6 (0.7 to 3.4)	9/9	1.2 (0.5 to 3.2)
General construction	18/38	0.6 (0.3 to 1.2)	34/36	0.8 (0.5 to 1.4)
Glass, clay, cement, stone products	3/6	0.7 (0.2 to 3.1)	4/2	2.2 (0.4 to 12.5)
Instruments, jewellery, and toys	6/13	0.8 (0.3 to 2.4)	8/7	1.6 (0.5 to 4.5)
Leather goods	1/2	0.8 (0.1 to 8.7)	7/0	INF†
Machinery manufacturing	9/30	0.5 (0.2 to 1.0)	26/18	1.4 (0.8 to 2.8)
Metal products, fabricated	15/12	2.3 (1.0 to 5.1)	8/5	1.8 (0.6 to 5.9)
Metal products, primary	5/7	1.2 (0.4 to 4.0)	2/5	0.5 (0.1 to 2.7)
Mining	5/6	1.1 (0.3 to 3.6)	2/2	1.2 (0.2 to 8.9)
Publishing	6/6	1.2 (0.4 to 4.1)	12/8	2.0 (0.8 to 5.2)
Railroad, highway, and water	17/28	0.8 (0.4 to 1.6)	19/29	0.6 (0.3 to 1.2)
Retail stores	18/27	1.0 (0.5 to 2.0)	20/15	1.5 (0.7 to 3.1)
Special trade construction	8/10	1.1 (0.4 to 3.0)	14/3	4.1 (1.1 to 14.9)
Wood and related products	5/16	0.4 (0.1 to 1.0)	5/4	1.3 (0.3 to 5.2)

*ORs for every employment in specific occupation and industrial groups adjusted for age, education, smoking, and number of jobs.
†Infinity.

based on one exposed case. Among men, there was a significant decreased risk for employment in educational services.

When we excluded cases with next-of-kin respondents, we usually observed slightly stronger positive associations than those presented in tables 1 and 2; however, none of the ORs changed by more than 20% or reached statistical significance.

We present duration-response results only for those occupational and industrial groups showing a significant association in the ever/never analyses or for which there was previous evidence of an association with stomach cancer. Among occupational groups for men (table 3), there was a non-significant increasing trend with longer duration employment as a salesperson ($p = 0.06$). There was a significant inverse trend with duration of employment as teaching professionals ($p = 0.002$). Among industrial groups, we observed a significant positive trend in risk with duration of employment in the leather goods industry ($p = 0.03$) and in special trade construction ($p = 0.04$). A non-significant positive trend was found with duration of employment in the publishing industry ($p = 0.13$). Duration of employment in the fabricated metal products industry showed no increase in risk with longer duration of employment. When next-of-kin cases were excluded from the analysis, the trend with duration of employment became slightly stronger and more significant for leather goods ($p = 0.02$) and special trade construction ($p = 0.03$).

Among women (table 4), there was a significant inverse trend ($p = 0.03$) with duration of employment as a scientist or other technical professional. There were no other significant duration-response trends for any of the occupation or industry groups. The risk for managers and government officials was significantly increased only among those with less than 10 years of employment.

The results for specific exposures based on the JEM are shown in table 5. Among men, we observed an increased risk of borderline significance for ever employment in jobs with asbestos exposure (OR = 1.5, 95% CI 0.9 to 2.4). No associations were observed with ever exposure to the other agents among both men and women. Among those who were exposed for less than 10 years, inverse associations were generally observed. For those with exposures of 10 or more years, a positive association of borderline significance was found for asbestos (OR = 1.9, 95% CI 0.9 to 3.8). We also observed non-significant positive associations for metal dust (OR = 1.4, 95% CI 0.8 to 2.5) and nitrosamines (OR = 1.3, 95% CI 0.8 to 2.2). Among women, increased risks were also linked to longer duration of exposure to metal dust (OR = 1.3, 95% CI 0.2 to 9.7) and nitrosamines (OR = 1.3, 95% CI 0.4 to 4.2) based on two and six exposed cases, respectively.

Exclusion of next-of-kin cases from the JEM analysis did not change most results substantially; however, the ORs were somewhat higher for longer duration of exposure among men exposed to metal dust (OR = 1.7; 95% CI 0.9 to 3.0). The associations with specific exposures did not differ substantially for cases classified into the Lauren classification of intestinal and diffuse types (data not shown). When we stratified analyses by smoking status, we found somewhat stronger associations among male non-smokers compared to smokers for specific dusts and pesticides; ORs among non-smokers: organic dust OR = 1.7 (95% CI 0.8 to 3.6), metal dust OR = 1.9 (95% CI 0.7 to 5.5), pesticides OR = 2.3 (95% CI 0.8 to 6.4); ORs among smokers: organic dust OR = 0.7 (95% CI 0.5 to 1.1), metal dust OR = 0.8 (95% CI 0.5 to 1.3), pesticides OR = 0.6 (95% CI 0.3 to 1.0). Among women, only metal dust exposure showed a stronger association with risk among non-smokers.

Table 4 Odds ratios (ORs) for stomach cancer by duration of employment in selected occupation and industry groups among women

	Duration (years)			
	<10		≥10	
	Cases/controls	OR* (95% CI)	Cases/controls	OR* (95% CI)
Occupational groups				
Agricultural and fishery workers	8/14	0.8 (0.3 to 2.0)	3/9	0.41 (0.1 to 1.6)
Metal workers	2/5	0.3 (0.1 to 1.7)	3/5	0.6 (0.1 to 2.6)
Machine and plant operators	5/7	0.8 (0.2 to 2.9)	1/3	0.4 (0.0 to 3.6)
Managers and governmental officials	8/2	8.3 (1.6 to 42.6)	10/9	1.5 (0.6 to 4.2)
Manufacturing labourers	9/7	2.0 (0.6 to 6.1)	6/5	1.1 (0.3 to 4.1)
Mining	3/4	0.9 (0.2 to 5.0)	0/0	IDF†
Office workers	18/21	1.5 (0.7 to 3.3)	43/38	1.5 (0.8 to 2.7)
Technical and science professionals	4/8	0.6 (0.15 to 2.1)	5/16	0.3 (0.1 to 0.9)
Transport and freight handlers	4/3	2.4 (0.5 to 12.1)	3/6	0.6 (0.1 to 2.5)
Industrial groups				
Agriculture, crops	6/14	0.5 (0.2 to 1.5)	3/8	0.4 (0.1 to 1.8)
Agriculture and forestry services	3/2	3.3 (0.5 to 20.8)	0/2	IDF†
Amusement and recreational services	4/1	8.5 (0.9 to 81.9)	4/4	0.8 (0.2 to 3.6)
Chemical products	6/8	0.8 (0.3 to 2.7)	3/0	INF‡
Financial institutions	4/6	1.2 (0.3 to 4.8)	5/5	1.6 (0.4 to 6.0)
Food and tobacco products	6/8	1.0 (0.3 to 3.4)	5/5	0.8 (0.2 to 3.3)
General construction	3/7	0.5 (0.1 to 2.3)	8/3	3.5 (0.8 to 15.6)
Glass, clay, cement, stone products	4/3	2.6 (0.5 to 12.7)	1/1	1.6 (0.1 to 30.3)
Leather goods	3/0		0/3	IDF†
Metal products, fabricated	1/3	0.2 (0.02 to 2.6)	2/4	0.4 (0.1 to 2.3)
National security	3/6	0.9 (0.2 to 3.9)	4/3	1.2 (0.2 to 5.7)
Publishing	1/1	1.6 (0.1 to 28.3)	7/6	1.3 (0.4 to 4.2)
Railroad, highway, and water transportation	2/4	0.7 (0.1 to 4.2)	2/2	1.1 (0.2 to 8.7)

*ORs for ever employment in specific occupation and industrial groups adjusted age, education, smoking, and number of jobs.
†Indefinite.
‡Infinity.

There were no significant associations between the self-reported exposures to specific agents and stomach cancer risk among men and women (data not shown). Further, the duration analysis showed no clear pattern of increasing risk with longer duration employment for most exposures. Among women, all the ORs in the duration analysis were based on small numbers (less than 10 exposed cases). Among men, metal dust and fume exposure of 10 or more years was associated with an increased risk of borderline significance (OR = 1.6, 95% CI 0.9 to 2.7). When we excluded next-of-kin subjects from the analysis, an increased risk of borderline significance was also found for ever exposure to asbestos among men (OR = 1.7, 95% CI 0.9 to 3.5), and risk was also increased among women (OR = 1.8, 95% CI 0.4 to 8.3; based on four exposed cases). However, there was no trend with longer duration of these self-reported exposures for either men or women.

DISCUSSION

Only a small number of occupations and industries emerged as potential risk factors for gastric cancer in our study population in Warsaw, Poland. The most suggestive finding was for work in the leather product industry, which showed an increased risk among men and women and an increasing trend in risk with duration of employment among men. Risk for stomach cancer was also significantly increased among male fabricated metal production workers. Employment in a few other industries was associated with an increased risk of stomach cancer. Among men, risk was significantly increased among those working 10 or more years in special trade construction. There were few women employed in these industries, so the risk patterns with duration are difficult to interpret. We only observed significantly increased risks of stomach cancer for managers and governmental officials among women.

We found no significantly increased risks for specific exposures that were of a priori interest estimated by our JEM. However, exposures of longer than 10 years to asbestos, metal dust, and nitrosamines showed non-significant excess risk among men. Longer duration exposure to metal dust and nitrosamines was associated with non-significantly increased risk among women.

Although several epidemiological studies have reported associations between occupation and the risk for gastric cancer, few studies have evaluated specific occupational exposures and the results have been somewhat inconsistent.[7 15] Occupations that have been associated with an increased risk of gastric cancer in multiple studies include miners and quarrymen, asbestos workers, farmers, fishermen, masonry and concrete workers, machine operators, metal workers, chemical and rubber workers, carpenters, transport workers, and sailors.[1 5 6 8] Occupational exposures that have been linked to stomach cancer risk include various dusts, such as mineral, metal, coal, and wood dust, and exposure to asbestos, nitrogen oxides, N-nitroso compounds, and ionising radiation.[1 5 7 8 15–17]

Our finding of an increased risk with employment in the leather product industry is in agreement with some previous reports.[6–8 18] Increased risks were observed in population based case-control studies in Montreal, Canada[7] and in Spain,[19] and in cohort studies in China[20] and in Sweden.[18] However, a few studies have shown no association. Compared with the general population, there was no increased incidence of stomach cancer among workers in the leather industry in Sweden[21] or Italy.[15] IARC determined that there is some evidence of increased risk of stomach cancer among male boot and shoemakers.[22] Workers in the leather industry are exposed to several carcinogens, including chromium, chlorophenols, and nitrosamines, during leather tanning.[6 8 11 15] In our study, we found a modest increase in risk with longer duration exposure to nitrosamines. The other carcinogens used in leather tanning were not assessed.

Among men, we observed a significantly increased risk of stomach cancer with work in the fabricated metal product

Table 5 Odds ratios (ORs) for stomach cancer and specific exposures among men and women

				Duration (years)			
				1–9		≥10	
Exposure to selected chemicals	Sex	Exposed cases/controls	Ever exposure OR (95% CI)	Cases/controls	OR* (95% CI)	Cases/controls	OR* (95% CI)
General dust	M	174/193	1.0 (0.7 to 1.4)	52/74	0.9 (0.6 to 1.5)	118/119	1.0 (0.7 to 1.5)
	W	41/57	0.8 (0.5 to 1.4)	24/28	1.0 (0.5 to 2.0)	15/29	0.6 (0.3 to 1.2)
Organic dust	M	108/136	0.9 (0.6 to 1.2)	50/75	0.8 (0.5 to 1.3)	54/61	0.8 (0.5 to 1.3)
	W	34/51	0.7 (0.4 to 1.3)	19/28	0.8 (0.4 to 1.5)	13/23	0.6 (0.3 to 1.3)
Inorganic dust	M	155/179	1.0 (0.7 to 1.4)	49/77	0.8 (0.5 to 1.3)	104/102	1.0 (0.7 to 1.5)
	W	27/41	0.9 (0.5 to 1.6)	20/25	1.1 (0.6 to 2.4)	6/16	0.5 (0.2 to 1.4)
Metal dust	M	55/64	1.0 (0.6 to 1.5)	18/39	0.6 (0.3 to 1.2)	37/25	1.4 (0.8 to 2.5)
	W	6/7	1.1 (0.3 to 3.5)	4/5	1.0 (0.3 to 4.2)	2/2	1.3 (0.2 to 9.7)
Asbestos	M	42/41	1.5 (0.9 to 2.4)	19/26	1.2 (0.6 to 2.3)	23/15	1.9 (0.9 to 3.8)
	W	1/3	0.3 (0.03 to 3.0)	1/2	0.4 (0.0 to 6.0)	0/1	IDF†
Pesticide	M	40/59	0.8 (0.5 to 1.2)	23/45	0.6 (0.4 to 1.1)	16/14	1.0 (0.5 to 2.3)
	W	12./24	0.7 (0.3 to 1.4)	8/15	0.7 (0.3 to 1.9)	3/9	0.4 (0.1 to 1.6)
Nitrosamines	M	65/77	1.0 (0.7 to 1.5)	18/40	0.6 (0.3 to 1.1)	46/37	1.3 (0.8 to 2.2)
	W	12/12	1.2 (0.5 to 2.8)	5/6	0.9 (0.2 to 3.1)	6/6	1.3 (0.4 to 4.2)

*ORs adjusted for age, education, smoking, and number of jobs.
†Indefinite.

industry where metal dust and nitrosamine exposure is likely. Likewise, in both the JEM analysis and our analysis of self-reported exposure, there was a non-significantly increased risk with 10 or more years of exposure to metal dust. This result is in agreement with other studies that observed increased stomach cancer risk with exposure to metal dust or work in the metal industry.[7 18 21–25]

We found an increased risk among men with 10 or more years of exposure to asbestos as assessed by the JEM. Some studies have shown evidence of asbestos bodies in gastrointestinal cancers, and the potential carcinogenicity of ingested asbestos fibres seems plausible.[6] However, results from the epidemiological studies have been mixed for stomach cancer.[1 6 7 15 26]

Work in special trade construction, which is likely to have exposure to mineral and wood dust, showed a modest increase in risk in our study population. Wood dust exposure has been evaluated in a few studies, but the findings are inconsistent and support for an exposure-response analysis is generally lacking.[1 6 16 17] The epidemiological studies are more supportive of an increased risk among carpenters, whereas results for the other wood related occupations are less consistent.[6 8 21 25]

We did not find a positive association with crop and livestock agriculture, mining, or work in the general construction industry, industries and occupations that have been linked to an increased risk of stomach cancer in some previous studies.[1 5 8 16]

We observed stronger associations for specific dusts and pesticides among men who were non-smokers. Smoking causes pulmonary obstruction and reduced clearance of inhaled particles, thereby resulting in lower exposure of the stomach to dusts and other particles that may be carcinogenic. Meyer and colleagues[27] hypothesised that stomach cancer would be increased among those with normal pulmonary clearance but not among those whose pulmonary clearance was impaired Our results provide some support for this hypothesis. However, other explanations such as lower exposure levels among smokers and chance cannot be ruled out.

Our analysis of occupation and risk of stomach cancer is primarily based on reported jobs and industry titles, a surrogate measure for workplace exposure, which limited our ability to directly relate exposures to stomach cancer. We combined the occupations and industries in groups with similar work exposures, and constructed a job-exposure matrix for selected dusts and fumes to improve our ability to evaluate specific workplace exposure. Moreover, we had data on self-reported exposures to agents, many of which have been previously associated with stomach cancer risk.

We do not believe that recall bias was a major factor in producing our study results. Occupational exposures are not largely recognised as potential risk factors for stomach cancer. The proxy respondents could introduce bias, since they are less likely to know details of the subjects' occupational history. We found some evidence for this in that we found slightly stronger positive associations when we excluded cases with next-of-kin respondents.

Many comparisons were made in analysis; therefore it is possible that some of our findings, increased or reduced, may have been due to chance. The increased odds ratios observed were generally modest, and mostly non-significant. Many occupations and industries showed inverse associations, particularly in short term exposure groups, probably due to a healthy worker effect. However, significant inverse trends in risk with duration of employment were found for teaching and science professionals among men and women, respectively. Many occupations and industries had small numbers

of exposed, particularly women, which limited our ability to evaluate risk.

In summary, in this population based case-control study in Warsaw, Poland, where some of the highest rates of stomach cancer have been reported, we found only a few significant positive associations with occupational factors. Our findings for leather goods production, asbestos, and metal dust exposure support findings from previous studies. Our results suggest that the high rates of stomach cancer in Poland are not substantially explained by occupational exposures.

ACKNOWLEDGEMENTS

This study was supported by US National Cancer Institute contracts N02-CP-40501, N01-CP-05626, and N02-CP-71103. We are grateful to the medical, pathology, and nursing staff in the Warsaw hospitals for case recruitment and diagnosis, and to the Survey Centre Institute of the Institute of Philosophy and Sociology at the Polish Academy of Science in Warsaw for assistance in training and coordination of interviewers. We thank Linda Lannom, Shyla Jagannatha, and Nancy Odaka at Westat, Inc., for their organisational and technical support. We also thank Anne Fleming, Roy Van Dusen, and Suzie Reyes of IMS, Inc., for programming support.

Authors' affiliations

S Krstev, M Dosemeci, W-H Chow, M H Ward, Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services, Bethesda, Maryland, USA
J Lissowska, W Zatonski, Division of Cancer Epidemiology and Prevention, Cancer Center and Institute of Oncology, Warsaw, Poland

Competing interests: The authors declare that they have no competing interests that affected the collection, analysis, or interpretation and publication of these data

REFERENCES

1 **Nyrén O**, Adami H-O. Stomach cancer. In: Adami H-O, Hunter D, Trishopoulos D, eds. *Textbook of cancer epidemiology*. New York: Oxford University Press Inc, 2002:162–87.
2 **Parkin D**, Pisani P, Ferlay J. Global cancer statistics. *CA Cancer J Clin* 1999;**49**:33–64.
3 **Pisani P**, Maxwell Parkin D, Bray F, *et al*. Estimates of the worldwide mortality from 25 cancers in 1990. *Int J Cancer* 1999;**83**:18–29.
4 **Zatonski W**, Tyczynski J. *Cancer in Poland in 1996*. Warsaw, Poland: The Maria Sklodowska Curie Memorial Cancer Centre, Department of Epidemiology and Cancer Prevention, National Cancer Registry, 1999.
5 **Nomura A**. Stomach cancer. In: Schottenfeld D, Fraumeni JF, eds. *Cancer epidemiology and prevention*. New York, Oxford: Oxford University Press, 1996:707–24.
6 **Cocco P**, Ward MH, Buiatti E. Occupational risk factors for gastric cancer: an overview. *Epidemiol Rev* 1996;**18**:218–34.
7 **Parent M-E**, Siemiatycki J, Fritschi L. Occupational exposures and gastric cancer. *Epidemiology* 1998;**9**:48–55.
8 **Raj A**, Mayberry JF, Podas T. Occupation and gastric cancer. *Postgrad Med J* 2003;**79**:252–8.
9 **Correa P**, Chen VW. Gastric cancer. *Cancer Surveys* 1992;**19/20**:55–76.
10 **Correa P**. Gastric neoplasia. *Current Gastroenterology Reports* 2002;**4**:463–70.
11 **Mirvish SS**. Role of N-nitroso compounds (NOC) and N-nitrosation in etiology of gastric, esophageal, nasopharyngeal and bladder cancer and contribution to cancer of known exposures to NOC. *Cancer Letters* 1995;**95**:17–48.
12 **Lissowska J**, Gail M, Pee D, *et al*. Diet and stomach cancer risk in Warsaw, Poland. *Nutr Cancer* 2004;**48**:149–59.
13 **Chow W-H**, Swanson CA, Lissowska J, *et al*. Risk of stomach cancer in relation to consumption of cigarettes, alcohol, tea and coffee in Warsaw, Poland. *Int J Cancer* 1999;**81**:871–6.
14 **Lissowska J**, Groves FD, Sobin LH, *et al*. Family history and risk of stomach cancer in Warsaw, Poland. *Eur J Cancer Prev* 1999;**8**:223–7.
15 **Cocco P**, Palli D, Buittai E, *et al*. Occupational exposures as risk factors for gastric cancer in Italy. *Cancer Causes Control* 1994;**5**:241–8.
16 **Cocco P**, Ward MH, Dosemeci M. Occupational risk factors for cancer of the gastric cardia. *J Occup Environ Med* 1998;**40**:855–61.
17 **Cocco P**, Ward MH, Dosemeci M. Risk of stomach cancer associated with 12 workplace hazards: analysis of death certificates from 24 states of the United States with the aid of job exposure matrices. *Occup Environ Med* 1999;**56**:781–7.
18 **Aragonés N**, Pollán M, Gustavsson P. Stomach cancer and occupation in Sweden: 1071-89. *Occup Environ Med* 2002;**59**:329–37.
19 **Gonzáles CA**, Sanz M, Marcos G, *et al*. Occupation and gastric cancer in Spain. *Scand J Work Environ Health* 1991;**17**:240–7.
20 **Kneller RW**, Gao Y-T, McLaughlin JK, *et al*. Occupational risk factors for gastric cancer in Shanghai, China. *Am J Ind Med* 1990;**18**:69–78.
21 **Chow W-H**, McLaughlin J, Malker HSR, *et al*. Occupation and stomach cancer in cohort of Swedish men. *Am J Ind Med* 1994;**26**:511–20.
22 **International Agency for Research in Cancer**. *IARC monographs on the evaluation of cancerogenic risks to humans. Vol. 25. Wood, leather and some associated industries*. Lyon: IARC, 1981.
23 **Ekström AM**, Eriksson M, Hansson L-E, *et al*. Occupational exposures and risk of gastric cancer in a population-based case-control study. *Cancer Res* 1999;**59**:5932–7.
24 **Xu Z**, Morris Brown L, Pan G-W, *et al*. Cancer risks among iron and steel workers in Ashgan, China, Part II: Case-control studies of lung and stomach cancer. *Am J Ind Med* 1996;**30**:7–15.
25 **Engel LS**, Vaughan TL, Vaughan TL, *et al*. Occupation and risk of esophageal and gastric cardia adenocarcinoma. *Am J Ind Med* 2002;**42**:11–22.
26 **Albin M**, Jakobsson K, Attewell R, *et al*. Mortality and cancer morbidity in cohorts of asbestos cement workers and referents. *Br J Ind Med* 1990;**47**:602–10.
27 **Meyer MB**, Luk GD, Sotelo JM, *et al*. The role of the lung in stomach carcinogenesis. *Am Rev Respir Dis* 1980;**121**:887–92.